Mobile Tagging and Accessibility Information Sharing Using a Geospatial Digital Library

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Abstract. Mobile tagging is an extension of social tagging that allows users to associate location-sensitive information with physical objects in the real world. This paper presents MoTag, a mobile tagging application that is used to help people with disabilities share up-to-date accessibility information about buildings and other physical structures to help them navigate their environment. MoTag integrates with G-Portal, a geospatial digital library for storing, managing and retrieving tags.

Keywords: Mobile tagging, Metadata, Accessibility, Information sharing, Geospatial digital library.

1 Introduction

People with disabilities face many obstacles as they navigate their environment and would welcome information that could help make this task easier. One category of information is the facilities that buildings and other physical structures provide for people with disabilities. Examples include wheelchair ramps, Braille numbers on elevators, and parking lots for the disabled. In this work, we term such information as "accessibility information". It is important to note that accessibility information helps not only people with disabilities but a wider cross section of people which includes the elderly and children as well.

Accessibility information may be obtained within a building or structure, through Web sites or printed guides. However, these sources of information may not be the most updated due to facility break downs, remodeling work or repairs being carried out. The lack of real-time information may lead to navigation problems if people with disabilities rely solely on such sources. In this paper, we discuss a possible solution to this problem through a mobile tagging application (MoTag) that interfaces with a geospatial digital library to allow users to share and retrieve accessibility information in real-time. In MoTag, users create, update and receive tags, which are metadata

D.H.-L. Goh et al. (Eds.): ICADL 2007, LNCS 4822, pp. 287–296, 2007.

describing accessibility information that are associated with buildings and physical structures. The geospatial digital library used is G-Portal [8, 9] and serves as a backend service to support tag management, processing and retrieval.

This paper follows with a review of the ideas behind mobile tagging and the G-Portal system. A description of the design and implementation of MoTag is then presented and findings of an initial user study of the system are provided. The paper concludes with a summary of our work and opportunities for future research.

2 Background

This section discusses mobile tagging and the G-Portal digital library which serve as the foundation for the MoTag project.

2.1 Mobile Tagging

The Web has evolved from a unidirectional information repository where access to information by users is the main focus, to a platform for collaboration in which content is generated and shared among users. Also known as Web 2.0, examples of such applications include blogs, wikis, social networking, media sharing and social tagging, among many others. As this new avenue for content-generation becomes increasingly popular, the resulting information explosion requires new techniques to manage, search and access such content.

Social tagging is one such approach for managing and discovering content on the Web and refers to the assignment of uncontrolled keywords to resources by users [10]. Such keywords are known as tags and are a simplified form of metadata. Tags are used to organize information, and because they are shareable, users have an alternative way to access content apart from search engines and Web taxonomies. Tags are a form of user-generated content, and popular applications include del.icio.us for tagging Web sites, and Connotea for research content. Besides these purpose-built applications, social tagging has also been used in blogs, wikis, social networking, media sharing and other sites because they have become an accepted way of managing and discovering content. Examples include Flickr and YouTube.

The use of Web 2.0 applications have thus far been mainly confined to desktop computers. However, the popularity of mobile devices and increasing availability of wireless networking access on these devices (e.g. GPRS, 3G, WIFI) suggests new opportunities for deploying similar Web 2.0 collaborative applications on these devices. One important characteristic of the mobile device that distinguishes it from a desktop computer is its mobility and this changing location creates a new dimension in terms of user-generated content. In particular, mobile tagging is one such application that extends Web-based social tagging by taking advantage of mobility. Here, tags (keywords, media elements and other metadata attributes) are applied to physical objects in the real-world as opposed to content (such as Web pages) in the virtual world. Mobile tagging is a promising area and in the research literature, has been applied to education [13], entertainment [4], tourism [3] and many others.

In this project, we apply the concept of mobile tagging to the provision of accessibility information for people with disabilities. While mobile tagging has been

employed in many domains, little known work has been done in this area even though there are many benefits that can be reaped. Our work introduces a mobile tagging application, MoTag (Mobile Tagger), that allows users with personal digital assistants (PDAs) to tag buildings and other structures with accessibility information, and to also receive such information. A crucial component of the application is its backend for managing, processing and retrieving tags and associated information. These operations are achieved using a geospatial digital library system known as G-Portal.

2.2 G-Portal

G-Portal is a digital library of geospatial and georeferenced resources, providing a variety of services to access and manage them [8, 9]. The resources maintained comprise mainly metadata records that describe actual resources, such as Web pages, images and other objects that are accessible on the Web. Other types of information managed by G-Portal include semi-structured data records and annotations.

Each resource contains among other attributes, a location attribute (if available) storing its geospatial shape and position, and a link to the corresponding actual resource. G-Portal provides a map-based interface that visualizes resources with location attributes on a map. This interface makes resources with known geographical locations easily and intuitively accessible and helps users discover the spatial relationships between resources. For resources without a location attribute, G-Portal provides a classification-based interface that organizes resources based on a customizable taxonomy. A query interface that supports searches for resources based on keywords and spatial operators is also available.

G-Portal organizes resources into projects in which each project contains a collection of resources that are relevant to a specific topic or learning activity. Within each project, resources are further grouped into layers for finer grained organization. Each layer serves as a category to store logically related resources. For example, a project studying flora and fauna in nature trails may include rivers, lakes and hills in a map layer, flora and fauna information in another, and annotations in a separate layer.

The G-Portal client is developed as a Java applet with all projects, layers and resources stored within a database server that supports XML and spatial operations. G-Portal can therefore be accessed from any Java-enabled Web browser, making it possible for users to easily access and manipulate personalized project space anywhere, anytime.

3 MoTag: Design and Implementation

MoTag is a mobile tagging application in which user-generated tags describing accessibility information are applied to buildings and other physical structures. Each building can have one or more tags. In MoTag, we extend the concept of keyword-based tags to include a richer form of metadata encompassing: the keyword that describes the physical structure, similar to Web-based tags; location of the object (GPS coordinates); one or more media elements that describe the object (e.g. image or video of an unusable wheelchair ramp); comments associated with the tag; and other implicit attributes captured at tag creation time including creator and creation time.

Since tags are associated with locations in the form of GPS coordinates, we require a system to efficiently store, manage and retrieve them. Here, we employ G-Portal for these tasks. The G-Portal digital library is ideally suited for our work because it is also designed to allow users to contribute resources, making the system a common platform for sharing mobile tags of accessibility information. MoTag is implemented as a Pocket PC-based front-end that communicates with the G-Portal server via sockets. Figure 1 shows the architecture of system. The client is the MoTag application running on a personal digital assistant (PDA) or other mobile device. The MoTag client interacts with the G-Portal digital library server for tag management, processing and retrieval functionality.

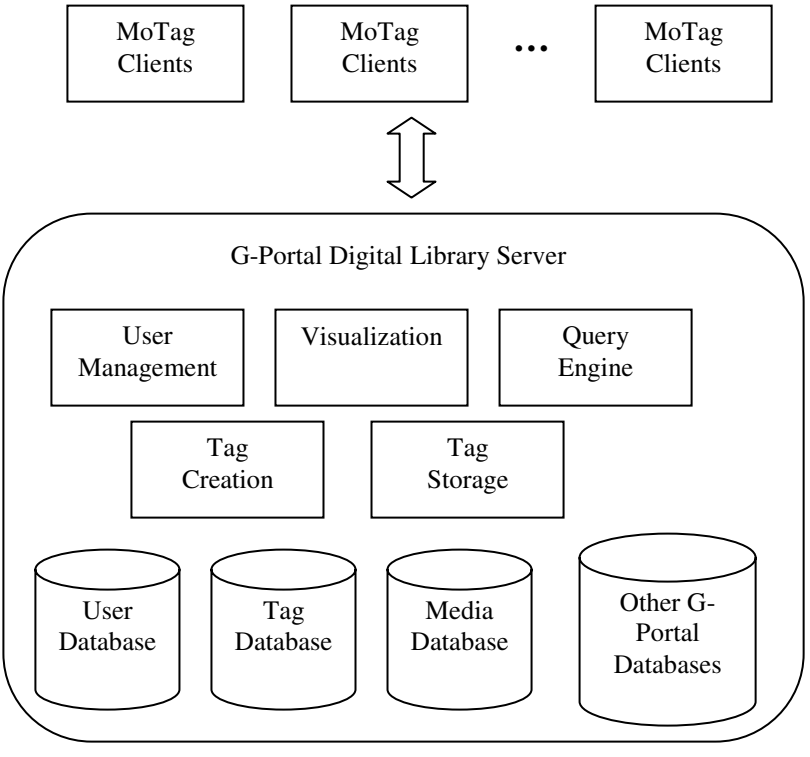

Fig. 1. MoTag system architecture

In a typical usage scenario, a user with a physical disability visits a shopping mall and discovers that the advertised wheelchair ramp on the building's front entrance is not usable and in need of repair. The user launches the MoTag application on his PDA and tags the offending facility with a keyword and some comments describing the state of the restroom. Using the camera mounted on his PDA, a picture of the ramp is also taken and attached with the tag. MoTag uses the PDA's GPS unit to capture the shopping mall's location as well. This information, constituting the tag is packaged by MoTag and uploaded to G-Portal. Some time later, another user planning

to visit the same mall browses for accessibility information on it. On launching MoTag, this user discovers the wheelchair ramp problem with this particular mall and considers going elsewhere.

Fig. 2. MoTag's map-based view (left) and tag creation interface (right)

Fig. 3. Viewing official accessibility information using MoTag

Figure 2 shows two of MoTag's screens running on a PocketPC emulator. The map-based view (on the left) gives the user an overview of the coverage area including the available tags (represented as circles). Our coverage area currently encompasses Orchard Road, which is Singapore's main shopping belt with many large malls and other buildings frequented by locals and tourists. From here, users are able to navigate the map by panning and zooming, view tags and create new tags. The

tag creation screen (right of Figure 2) requires users to enter the tag, comments and optional attachments which are media elements associated with the tag. The physical location of the tag (coordinates) and building name are also shown.

For viewing tags, a screen similar to the tag creation interface is used except that content is read-only. In addition to the tag information, MoTag provides users with official accessibility information obtained from government agencies. Such information includes entrances to the buildings, lift access, restrooms and so on (see Figure 3). Since the number of tags that users create could be large, several methods are implemented in MoTag to support the retrieval of tags:

- Manual selection from the map. Here, users select a building on MoTag's map-based interface. As shown in Figure 2, buildings that have been tagged are indicated with circular icons. Selecting an icon causes MoTag to present a list of tags for browsing (see Figure 4).
- Browse tag list. MoTag displays an alphabetical list of tags (see Figure 4). Selecting a tag results in a list of associated buildings being displayed. Users may also filter the list by specifying the tag's starting alphabet.
- Search for tags. Users enter terms and receive a list of matching tags. From here, users may further browse and filter the retrieved list.

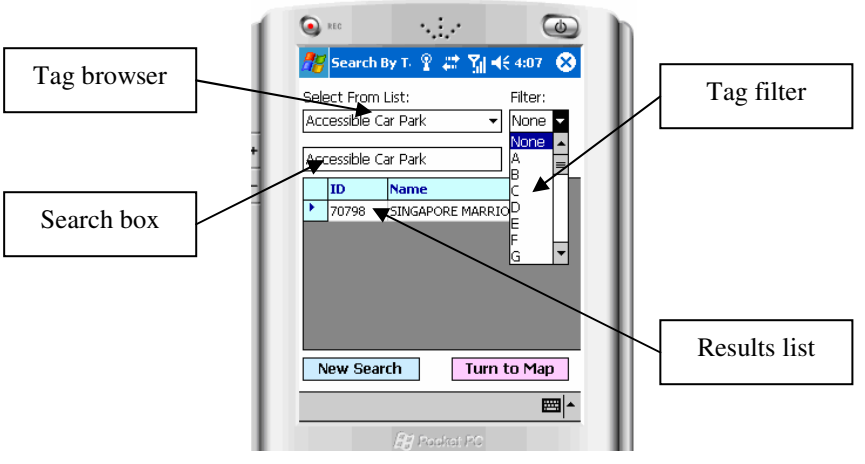

Fig. 4. MoTag's browse and search interface

In all cases, MoTag interacts with the G-Portal server to retrieve the relevant tags. To reduce latency and improve response times, tags that are created by the current user or previously retrieved are cached in the mobile device. At any point in time, users can then choose to synchronize with the G-Portal server to obtain the latest updates. During synchronization, only textual tag information is retrieved. Multimedia elements associated with each tag are only retrieved if users elect to do so. This design reduces the communication time with G-Portal and also reduces network charges (if applicable, for example when using GPRS). Communication is accomplished via XML for maximum portability. Doing so allows for different

client-side access mechanisms, thus extending the reach and applicability of the digital library system. For example, G-Portal has been also been used in the desktop and mobile environments for educational applications [5, 12].

4 Evaluation

A pilot study of MoTag was conducted to evaluate the usability of the system using the heuristic evaluation approach. Heuristic evaluation [11] is a usability engineering method for discovering usability problems in a user interface design so that they can be attended to as part of an iterative design process. Heuristic evaluation involves examining the interface and judging its compliance with recognized usability principles (known as the "heuristics"). In the evaluation, Nielsen's [11] 10 usability heuristics were adopted (see Table 1).

4.1 Participants and Tasks

Twelve volunteers (four females and eight males) were recruited for the evaluation. Participants' ages ranged between 16-45 and all owned a mobile device or at least had experience using one.

Four tasks were performed by the participants. The first three tasks involved searching and viewing specific tags while the fourth task required participants to create a new tag. The Orchard Road area was selected as the site of the evaluation because it was a popular shopping belt and provided a realistic setting for the application. Specific buildings (not named in this paper) were also selected based on popularity with shoppers. Participants were first briefed about the ideas behind mobile tagging and the MoTag system. They were then issued with PDAs and after giving them an opportunity to experiment with the system, they were asked to visit the Orchard Road area to complete the tasks. The time taken to complete each task was also noted. The four tasks were:

A. Determine if Building A has accessible toilets.
B. Determine if Building B has reserved parking facilities for people with disabilities.
C. Determine if Building C is accessible to people with disabilities.
D. Select a building and create a tag for accessibility information.

Upon completion of the four tasks, participants completed a questionnaire to rate the conformance of MoTag to each of the 10 usability heuristics on a scale of 1 (low conformance) to 5 (high conformance). They were also asked to provide qualitative feedback on the system.

4.2 Results and Analyses

Table 1 shows the results of the evaluation. The values in the rating column (maximum of 5, minimum of 1) were obtained by averaging the responses of the 12 participants. Values closer to 5 suggest strong conformance for a heuristic while values closer to 1 indicate weak conformance.

As shown in the table, participants rated most of the heuristics relatively highly with scores of around 4. This suggests that participants found MoTag to be a usable system as no major usability issues were noted. However, one heuristic, "Help and documentation", did not score well relatively. This was understandable for two reasons: (1) MoTag is a prototype application and as such did not have documentation; (2) the idea of mobile tagging is relatively new and thus users might need more assistance to accomplish their tasks.

The time taken to complete each of the four tasks was also recorded. This was approximately 30 seconds for Tasks A, B and C which involved similar operations. Task D took about 65 seconds. Although there are no established benchmarks for comparison, these times appear to be reasonable because apart from MoTag, the only way to obtain accessibility information currently along Orchard Road is either by actually visiting the building or by consulting printed sources. These two alternatives are however rather cumbersome especially for people with disabilities.

In addition, many participants commented that the limited screen sizes and keypads made navigation, searching and data entry difficult. For example, many found that map-based view provided only a small coverage area, thus requiring some amount of panning and zooming. Other participants commented on the need to switch between multiple screens in order to search and view tags. A few remarked on the slow response times of the PDA, while others mentioned the difficulty of entering tag data or search terms due to the limited input facilities. We note however that many of these issues are inherent in applications running on mobile devices and are not unique to MoTag. In designing and implementing mobile applications, there is a recognized trade-off between mobility and the device capability [1]. Nevertheless, because these are identified problems raised during the evaluation, various input/output alternatives could be experimented with in future work.

Table 1. Evaluation results using Nielsen's 10 usability heuristics

Heuristic	**Rating**
Visibility of system status	4.0
Match between system and the real world	4.1
User control and freedom	3.9
Consistency and standards	4.0
Error prevention	4.0
Recognition rather than recall	4.0
Flexibility and efficiency of use	3.5
Aesthetic and minimalist design	4.0
Help users recognize, diagnose, and recover from errors	4.0
Help and documentation	2.9

5 Discussion and Conclusion

In this paper, we present MoTag, a mobile tagging application targeted at helping users share accessibility information by associating buildings and other physical structures with tags or metadata, consisting of both textual attributes and media elements. The location-based nature of the application requires efficient geospatial data management functionality and in our design, we integrate MoTag with G-Portal, a geospatial digital library. G-Portal lends itself well to the task because the system is designed for managing geospatial and georeferenced resources. Further, because G-Portal is also designed for information sharing among digital library users, it is able to support the creation and sharing of tags among MoTag users. As societies begin to recognize the need for helping people with disabilities using assistive technologies, MoTag has the potential to benefit this segment of users by providing timely information that could help them navigate their environment.

MoTag shares similar objectives with existing mobile tagging systems in the provision of services for creating and sharing tags describing physical objects. For example, AURA (Advanced User Resource Annotation) [2] links physical objects and the virtual world using a barcode scanner attached to a PDA. By scanning the barcode, information (if available) about the item is displayed. Users may also add comments which are then uploaded to a server. Urban Tapestries [7] allows users to author location specific multimedia information, similar to the concept of tagging. Using a PDA equipped with a GPS unit, users can tag a location with text, sound, images and video. These tags can be shared with other users. In contrast to these systems, the advantage of MoTag is that it integrates with a geospatial digital library backend (G-Portal) to provide a richer range of services for tag management, processing and retrieval such as strong querying facilities including the ability to perform spatial queries, collection building, and the ability to share tags across both the mobile and Web platforms. The integration of MoTag with a digital library is similar to the work of the TIP/Greenstone bridge project [6] that combines a mobile tourist guide with the Greenstone digital library. Like G-Portal, Greenstone provides an array of digital library services to manage and deliver information, but it relies on the TIP (Tourist Information Provider) system for geospatial data operations. G-Portal, on the other hand, was built with geospatial data management from the start and hence is ideally suited for mobile tagging tasks.

Work on MoTag is ongoing. As revealed in the pilot study, improving the user interface to overcome the limited I/O capabilities of PDAs and other mobile devices is one area of research. We are investigating techniques for automating tag recommendation to reduce the burden of manual searching and browsing. In addition, the results of the pilot study may not be generalizable due to the small sample size. Further work could involve a greater variety of tasks and different types of users such as novices and experts, people with different disabilities, and varying age groups. As part of this larger evaluation, a comparison of MoTag against the use of existing resources for accessibility information would also be conducted to determine the effectiveness of the system. Next, as designed, MoTag is not suitable for people with visual impairments. One possible area of future work could investigate alternative interfaces for such people. Finally, because MoTag uses GPS, participants found that the system could only capture coordinates outdoors making it difficult to use at times. Relying on GPS alone also affords only a coarse grained

form of information organization since tags are applied to the building level and not within buildings. This is a recognized limitation of GPS and in future work, other positioning technologies such as WIFI triangulation, radio beacons, and RFID tags could be employed.

Acknowledgments. This work is partly funded by A*STAR grant 062 130 0057.

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